

CLAIMS

1. A mask for use in a lithographic projection apparatus, the mask comprising a plurality of isolated areas that contrast with a background and represent features to be printed in manufacture of a device, said isolated areas arranged generally in an array; and a plurality of assist features smaller than said isolated areas and positioned so as to make said array more symmetric.

10 2. A mask according to claim 1 wherein said isolated areas are arrayed in groups defining a unit cell and said assist features are positioned so as to make said unit cell more symmetric.

15 3. A mask according to claim 2 wherein said isolated areas are positioned proximate at least one of the points of at least one regular unit cell and at least one assist feature is positioned proximate a point of the regular unit cell not occupied by the isolated areas.

20 4. A mask according to claim 3 wherein said isolated areas are positioned at three corners of a rectangular unit cell and said assist features are positioned at the fourth corner.

25 5. A mask according to claim 1 wherein said assist features are positioned so as to reduce the effect of at least one odd aberration in a wavefront produced by said mask pattern when illuminated by exposure radiation in said lithographic projection apparatus.

30 6. A mask according to claim 1 wherein said assist features are positioned along at least part of the edge of said array so as to make the surroundings of features at or near the edge of the array more similar to the surroundings of features in the interior of the array.

7. A mask according to claim 1 wherein said assist features are positioned so as to reduce the effect of at least one of 3 wave and comatic aberration in the wavefront produced by said mask pattern when illuminated by exposure radiation in said lithographic projection apparatus.

8. A mask according to claim 1 wherein said assist features have a contrast to the background of said mask equal to a contrast to the background of said mask of said isolated areas.

9. A mask according to claim 1 wherein said isolated features are more transparent to the exposure radiation of said lithographic projection apparatus than said background.

5 10. A mask according to claim 1 wherein said isolated features are more reflective of the exposure radiation of said lithographic projection apparatus than said background.

11. A mask according to claim 1 wherein said isolated features impart a different phase shift than said background.

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12. A mask according to claim 1 wherein said assist features are smaller than a critical dimension of said mask.

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13. A mask according to claim 12 wherein said assist features are smaller than a resolution limit of said lithographic projection apparatus.

14. A method of making a mask for use in a lithographic projection apparatus, the method comprising:

20 defining a plurality of isolated areas that contrast with the background and represent features to be printed in manufacture of a device, said isolated areas arranged generally in an array; and

defining a plurality of assist features smaller than said isolated areas and positioned so as to make said array more symmetric.

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15. A method according to claim 14 further comprising:

determining wavefront aberrations in an aerial image to be produced in said lithographic apparatus by the pattern of said isolated areas; and

determining positions, shapes and sizes for said plurality of assist features so as to reduce aberrations in said aerial image.

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16. A method according to claim 15 wherein said positions for said plurality of assist features are determined so as to reduce at least one of 3 wave and comatic aberrations.

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17. A method of manufacturing a device using a lithographic projection apparatus comprising:

imaging irradiated portions of a mask onto target portions of a substrate, wherein said mask is provided with a plurality of assist features smaller than said isolated areas and positioned
5 so as to make said array more symmetric.

18. A method according to claim 16 wherein said device includes a memory array.

19. A device manufactured according to the method of claim 17.

10 20. A method according to claim 17 wherein said assist features have a largest dimension less than 50% of the wavelength of said projection beam.

15 21. A method according to claim 20 wherein the largest dimension is in the range of from 30 to 40% of the wavelength of said projection beam.

20 22. A mask for use in a lithographic projection apparatus, the mask comprising:
a plurality of isolated areas that contrast with a background and represent features to be
printed on a substrate, said isolated areas arranged generally in an array and being
substantially mutually identical; and

a plurality of assist features that are smaller than a resolution limit of said apparatus, the
assist features being positioned with respect to the isolated features such that a difference
between intensity profiles of mutually adjacent isolated features in a mask image is reduced.

25 23. A mask according to claim 22, wherein said mask image is an image developed in a layer
of photosensitive material.